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(54) Lamp and lighting apparatus utilizing same.

(57) A lamp (L1) comprises a light-transmitting airtight container such as glass tube (1) provided with portions to be sealed at both ends thereof, a light emitting means, including a fluorescent luminous layer (7) and electrodes (3), provided in the light-transmitting airtight container and a metal oxide layer (6) formed directly or indirectly on an inner surface of the light-transmitting airtight container and vitrified at least at the seal portion thereof (6a). A lighting apparatus (P1) comprises a main body (9), the lamp (L1) mounted to the main body (9) of the structure described above and an operating unit (10) mounted to the main body (9) for operating the lamp (L1).

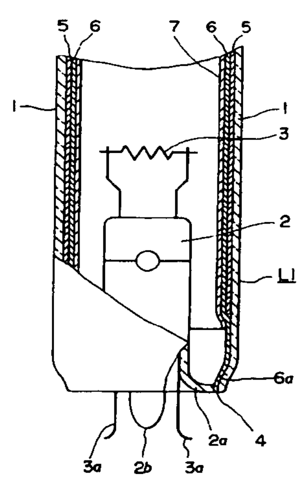

FIG. 2

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BACKGROUND OF THE INVENTION

[Field of the Invention]

This invention relates to a lamp such as a fluorescent lamp provided with a metal oxide layer and also relates to a lighting apparatus provided with the lamp.

[Description of Related Art]

Already known is a fluorescent lamp which has a particulate metal oxide layer formed between a glass tube and a fluorescent luminous layer in order to maintain a good appearance, to improve luminous flux maintenance factor or to cut ultraviolet rays.

For example, the Japanese Patent Laid-Open Publication No. 3-114136 discloses a fluorescent lamp which has a metal oxide layer formed in order to maintain a good appearance and to improve the luminous flux maintenance factor. Fig. 7 is a sectional view partially illustrating the fluorescent lamp disclosed in this Japanese Patent Laid-Open Publication. Referring to Fig. 7, the fluorescent lamp includes a glass tube 71 and mounts 72, which are sealed onto both ends of the glass tube 71, to constitute a light-transmitting airtight container. The mount 72 supports a discharge electrode 73 in the tube 71. A metal oxide layer 74, which is composed of metal oxide particles, is formed directly or indirectly to an inside surface of the glass tube 71, and a fluorescent luminous layer 75 is formed on the metal oxide layer 74. A very small amount of mercury and argon, which function as discharge media, is normally sealed in the light-transmitting airtight container.

When the mount 72 is installed in a sealing manner to the tube 71, the metal oxide layer 74, formed to a portion to which the mount 72 is mounted, is removed together with the fluorescent luminous layer 75 because phosphor particles or metal oxide particles remaining in the sealing portion prevent the glass at the sealed portion from melting and welding, thus causing leakage or crack.

For the reason described above, a sealing step is preceded by a neck cleaning step for removing phosphor particles and metal oxide particles from a portion to be sealed so as to leave no phosphor particles or metal oxide particles at the sealing portion.

The work for removing metal oxide particles from such a portion to be sealed, however, is more difficult than a work for removing fluorescent material particles. This is attributable to the particle diameters of the metal oxide particles which are smaller than those of the fluorescent material particles, and therefore, the metal oxide particles are liable to remain in a glass tube. For this reason, a fluorescent lamp coated with a particulate metal oxide had a defect of a lower yield than the fluorescent lamp which is not coated with the metal oxide particles.

This defect was not limited only to fluorescent lamps and it was common to all lamps coated with metal oxide particles.

SUMMARY OF THE INVENTION

An object of the present invention is to substantially eliminates defects or drawbacks encountered in the prior art described above and to provide a lamp which eliminates the need for removing metal oxide particles or permits a simplified removing step even if such removal is required, and which ensures a minimized reduction in yield even if the metal oxide remains.

Another object of the present invention is to provide a lighting apparatus which is equipped with the lamp of the characters described above.

These and other objects can be achieved according to the present invention by providing, in one aspect, a lamp comprising:

a light-transmitting airtight container provided with a seal portion;

a light emitting means provided in the light-transmitting airtight container for emitting light; and

a metal oxide layer directly or indirectly formed inside the light-transmitting airtight container and vitrified at least at the seal portion thereof.

In another aspect of the present invention, there is provided a lamp comprising:

a glass tube;

a mount forming a light-transmitting airtight container together with the glass tube and having discharge electrodes sealed at the seal portions formed to the longitudinal end portions of the glass tube;

a metal oxide layer formed inside the glass tube and vitrified at least at the seal portions;

a fluorescent luminous layer formed inside the metal oxide layer; and

a discharge medium sealed in the light-transmitting airtight container for exciting the fluorescent luminous layer.

In a further aspect of the present invention, there is provided a lamp comprising:

a light emitting tube containing a discharge medium therein and having discharge electrodes so as to oppose to one another;

a light-transmitting airtight container containing said light emitting tube and having a seal portion; and

a metal oxide layer formed inside the light-transmitting airtight container and vitrified at least at the seal portion.

In these aspects of the present invention, the followings are to be noted.

The lamp includes a low-voltage mercury vapor discharge lamp such as a fluorescent lamp, a rare gas discharge lamp, a high-intensity discharge lamp tube , etc.

The seal portion(s) refers to a junction between a plurality of members which are joined to constitute the light-transmitting airtight container. A typical tubular fluorescent lamp, for example, has sealed sections on both ends thereof.

The light-transmitting airtight container is composed of, for example, a glass tube, and if necessary, the light-transmitting airtight container may be partially composed of a metal or ceramic.

The light emitting means is a constituent necessary for causing the electrodes, lead wires, mercury vapor, etc. to emit light. In the case of a high-intensity discharge lamp, the constituent corresponds to a light emitting tube or the like housed in an outer tube, or it corresponds to a filament or the like in the case of an electric tube. The electrode may be one located outside the light-transmitting airtight container as in the case of a so-called electrodeless discharge lamp rather than being limited to a filament provided in the glass tube as in the case of a typical fluorescent lamp.

The expression "directly formed" given above means that the metal oxide is coated directly on the inner surface of the glass tube in the case of a fluorescent lamp. The expression "indirectly formed" given above means that, in the case of a so-called rapid start fluorescent lamp, for example, a transparent conductive coating is formed on the inner surface of the glass tube and the metal oxide layer is formed thereon. This means that various types of coatings may or may not be formed for another purpose between the light-transmitting airtight container and the metal oxide layer.

The metal oxide layer includes, for example, an aggregate of particulate metal oxides having smaller particles than those of the fluorescent material, which is coated in a layer. Although it is essential to form a layer, the components of the layers need not be 100 96 the same material and an additive may be present. Further, in the seal portion, the metal oxide may be diffused in the glass tube which constitutes the light-transmitting airtight container. At a portion other than the seal portion, the metal oxide layer may or may not be vitrified.

The term "vitrified" means that, when a metal oxide particles, for example, are used, the mode of the metal oxide particles changes and the metal oxide particles are fused with another one or melted and diffused into the glass bulb, or it means that the level, at which recognition as particles is possible, lowers.

The lamp includes a low-voltage mercury vapor discharge lamp represented by a straight-tube type, annular type, compact type, or electric tube type fluorescent lamp for general lighting and a rare gas fluorescent lamp or the like employed as a light source for reading.

The discharge electrode means a filament coil or the like, and the discharge medium means a Penning gas such as mercury vapor and argon gas in the low-voltage mercury vapor discharge lamp, or a xenon gas or the like in a rare gas fluorescent lamp.

The lamp may be a high-intensity discharge lamp such as a high-voltage sodium lamp, a metal halide lamp, or a high-voltage mercury vapor discharge lamp.

The light emitting tube refers to the inner tube of the high-intensity discharge lamp described above and the light-transmitting airtight container refers to the outer tube of the high-intensity discharge lamp.

The term used herein "seal portion (section)" refers to the sealed section or portion of the outer tube, or a section or portion to be sealed.

In preferred embodiments of the above respective aspects of the present invention, a transparent conductive film is formed between the inner surface of the light-transmitting airtight container and the metal oxide layer.

The seal portion is composed of a junction of two members and a metal oxide which has a vitrified metal oxide is present at the junction of the two members. At least one of the two members constituting the seal section is comprised of a glass member and the vitrified metal oxide is present at least on a side of the glass member of the seal portion. At least one of the two members constituting the seal portion is comprised of a glass member and the metal oxide is diffused in the glass member at the seal portion.

The seal portion is constituted by an end of the light-transmitting airtight container which is pinch-sealed.

The metal oxide layer is composed of fused particles in the seal portion. The metal oxide layer comprises metal oxide particles except at the seal portion and in the vicinity thereof. The particulate metal oxide has average primary particle diameter of 0.1μ m or less and average thickness of 0.5μ m or less. The metal oxide layer includes at least zinc oxide as one of constituents thereof.

The fluorescent luminous layer is formed on the metal oxide layer excluding at the seal portions.

In these preferred embodiments, the two members refer to the glass tube and a mount, which has flare glass or exhaust tube sealed onto an end of the glass tube, in a general lighting fluorescent lamp, for example. Further, the two members in a high-intensity discharge lamp refer to mounts which have an outer glass and a mount which has flare glass and which supports the light emitting tube.

The expression "at least one of the two members is a glass member" refers, for example, to a glass tube in a general lighting fluorescent lamp, and it means that the other one is also made of glass if a part of the light-transmitting airtight container is made of a metal or ceramic as in the case of a display fluorescent lamp. As the expression "at least one of them is a glass member" implies that both members may be glass members.

The metal oxide layer refers to the portion wherein the metal oxide has been diffused as a result of the diffusion of the metal oxide into the glass member. The boundary of the portion wherein the metal oxide has been diffused may not be clearly defined from the portion wherein the metal oxide has not been diffused.

The term "fused particles" means "does not have the particulate property" and means that, for example, after the metal oxide particles are applied, the metal oxide particles are melted and vitrified and then fused together.

The average primary particle diameter is the average particle diameter measured under a condition free of aggregation. The particles were photographed by using an electron microscope and the diameter of each particle was measured to calculate the mean value. The particles are not spherical and therefore, they were measured at their largest widths. Further, the thickness varies from one point to another, and therefore, the mean value was determined by averaging the values obtained at several points. For instance, in the case of a straight-tube fluorescent lamp, measurement was performed at three points, namely, the center and both ends, and the average value was determined from the three measurements. Both the ends mean the areas in the vicinity of the electrodes.

The transparent conductive film is, for example, a part of a tin oxide which has been reduced to develop conductivity in the case of a rapid start type fluorescent lamp.

In a still further aspect of the present invention, there is provided a lighting apparatus comprising:

a main body;

a lamp mounted to the main body; and

an operating unit mounted to the main body for operating the lamp,

the lamp unit comprising the structural features mentioned hereinabove in the one, another and further aspects of the present invention.

As the lighting apparatus, a lighting fixture for facility or house for general lighting purpose, for example, will be applied. In addition, a tube-shaped fluorescent lamp, a liquid crystal projector, and an industrial lighting apparatus such as one for photochemical reaction may be applied.

According to the above various aspects of the present invention and preferred embodiments thereof, the metal oxide layer is vitrified at least at the seal portion, allowing the metal oxide, for example, to stretch as the glass member stretches. Hence, even if the metal oxide remains, there are fewer chances of the seal portion incurring a crack or leakage after sealing. Therefore, the need for removing the metal oxide before sealing can be eliminated, or even when the metal oxide has to be removed, the removing procedure can be simplified. Further, even if the seal portion is not made of a glass member, the metal oxide vitrifies and functions as an adhesive agent at the seal portion, thus effecting the operation stated above. It is not necessary that all the metal oxides in the metal oxide layer at the seal portion be vitrified. In a practical application, the metal oxides need to vitrify at more than a certain rate, but even slight vitrification provides the operation mentioned above in comparison with the case where no vitrification takes place.

The lamp may have a metal oxide remaining in the junction of the two members, and the metal oxide is vitrified, so that the similar operation to that in the lamp described above will be attained.

At least one of the two members constituting the seal portion is composed of a glass member and hence the glass member is heated to the softening point or higher in the sealing process. The heat during the sealing process automatically vitrifies the metal oxide, causing the metal oxide layer, which has the vitrified metal oxide, to remain at the junction of the two members. Since the remaining metal oxide has

been vitrified, the similar operation to that described above will be obtained.

At least one of the two members constituting the seal portion is composed of a glass member and hence the metal oxide vitrifies at the seal portion and diffuses into the glass member.

In a case where the lamp is provided with the sealed section pinch- or press sealed on an end of the light-transmitting airtight container, this lamp also provides the similar operation to that described above.

The metal oxide at the sealed section does not have the particulate property. The metal oxide layer is partially composed of metal oxide particles except at the sealed section and the vicinity thereof. It provides the similar operation to that described above because the metal oxide at the sealed section vitrifies and loses the particulate property.

The fluorescent luminous layer is formed, excluding at the sealed section, and therefore, the fluorescent luminous layer does not cause leakage or crack. Moreover, unlike the case of the metal oxide, it is relatively easy to remove the fluorescent luminous layer from the seal section prior to sealing.

The whole fluorescent luminous layer is formed on the metal oxide layer, so that there is no boundary between the coated portion and uncoated portion of the metal oxide layer, thus allowing the fluorescent luminous layer to be coated evenly. Presence of a boundary portion would change the surface condition after the fluorescent luminous layer is coated at the boundary, making it difficult to coating the fluorescent luminous layer evenly.

The metal oxide layer includes at least zinc oxide as one of the constituents, making vitrification easier.

The metal oxide layer has a small average primary particle diameter, namely, 0.1μ m or less and a small average thickness, namely, 0.5μ m or less, making vitrification easy. An average particle diameter exceeding 0.1 μ m or an average thickness exceeding 0.5 μ m make vitrification difficult, leading to more chances of the sealed section developing a crack or leakage.

The lamp may have a transparent conductive coating as in the rapid start fluorescent lamp, but the present invention can also be applied to this type of lamp. In this case, particularly, the changes in resistance of the transparent conductive coating during the service life can be restrained and the discoloration due to reaction with a discharge medium such as mercury can also be restrained. Further, if the metal oxide absorbs ultraviolet rays as in zinc oxide ZnO, titanium oxide TiO_2 or the like, then the oxidation of the transparent conductive coating caused by ultraviolet rays can be restrained.

The lighting apparatus utilizing the lamp of the structures and characters described above can be achieved substantially the same effects as those described above with reference to the lamps.

The natures and further features of the present invention will be made more clear from the following descriptions made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

Fig. 1 is a front view showing a rapid start fluorescent lamp, having a portion enlarged in section, of a first embodiment according to the present invention;

Fig. 2 is a front view showing an end portion of the fluorescent lamp of Fig. 1 in an enlarged scale;

Fig. 3 is a front view of a lighting apparatus equipped with the fluorescent lamp of the first embodiment of Fig. 1;

Fig. 4 is a front view showing a portion near an end portion of an annular fluorescent lamp of a second embodiment of the present invention;

Fig. 5 is a front view showing a part of a compact fluorescent lamp, partially in section, of a third embodiment according to the present invention;

Fig. 6 is an enlarged front view, partially broken away, of a high-intensity discharge lamp of a fourth embodiment according to the present invention; and

Fig. 7 is a front view showing a conventional fluorescent lamp partially broken away.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of the present invention will be described hereunder with reference to Figs. 1 and 2.

Referring to Figs. 1 and 2, a fluorescent lamp L1 comprises a straight-tube 1 made of soda-lime glass, a stem 2 made of lead glass, which is equipped with a discharge electrode 3 made of a filament coil, and a seal mount 4 sealing the tube 1 and the stem 2 at each end of the fluorescent lamp L1. The tube 1 and the stems 2 together form a light-transmitting airtight container. A transparent conductive coating 5 is formed on the inner surface of the tube 1. The transparent conductive coating 5 employs tin oxide as the major constituent element and it has been partially reduced to exhibit conductivity. The transparent conductive

coating 5 is formed on the whole inner surface of the tube except on both ends of the tube 1, and therefore, the transparent conductive coating 5 is not formed at the seal mount 4 and in the vicinity thereof. The thickness of the transparent conductive coating 5 is approximately 0.1 μ m, and it is 0.1μ m or less when the coating is formed precisely.

A metal oxide layer 6 is formed inside the transparent conductive coating 5 and on the inner surface of both ends of the tube 1 where the transparent conductive coating 5 is not formed. The metal oxide layer 6 is also formed inside the seal mount 4 forming a junction between an end of the tube 1 and the distal end of a flare glass 2a of the stem 2 at each end of the fluorescent lamp L1. The materials used for the metal oxide layer 6 are, for example, zinc oxide ZnO and titanium oxide TiO_2. The metal oxide layer 6 has been produced by coating the metal oxide particles of the zinc oxide ZnO and titanium oxide TiO_2, having an average particle diameter of 0.1μ m or less, to provide a thickness of about 0.5μ m. The metal oxide layer 6 is vitrified at least at the seal mount 4 portion (reference numeral 6a denotes the vitrified portion) due to the reason which will be discussed later. In this embodiment, the area in the vicinity of the seal mount 4, i.e., the area where the end of the tube 1 is deformed, is also vitrified.

Formed on the inner surface of the metal oxide layer 6 is a fluorescent luminous layer 7 which is made of, for instance, a three-wavelength band luminescent type rare earth phosphor of a mixture of three types or a continuous wavelength luminescent type halophosphate phosphor. If the rare earth phosphor of the mixture of three types is used, the layer will have a thickness of 20 to 40 μ m. The dimensional proportion is not shown in the drawing.

Sealed inside the tube 1 is an extremely small amount of mercury and rare gases such as argon Ar, krypton Kr and xenon Xe in a discrete form or a mixed form as the discharge medium. The rare gases are sealed in under a pressure of about 500 pascal.

Formed on at least one end of the tube 1 is an exhaust tube 2b, and lead wires 3a which are electrically connected with the discharge electrode 3 are led out from this end. Bases 8 are mounted on both ends of the tube 1 and the lead wires 3a are electrically connected to base pins 8a provided on the bases 8.

Fig. 3 is a front view of a lighting apparatus such as a lighting fixture on which the rapid start fluorescent lamp L1 is mounted. The lighting apparatus D1 incorporates a lighting circuit 10 such as a ballast in a main body 9 of the apparatus, and the electrical and mechanical connection of the main body 9 with the rapid start fluorescent lamp L1 is achieved through sockets 11.

The rapid start fluorescent lamp L1 will be manufactured in the following manner.

First, the inside of the tube 1 is cleaned, then the transparent conductive coating 5 is formed inside the tube 1. The method for producing the transparent conductive coating 5 is already known. For example, hot vapor of dimethyl stannic chloride is introduced into the tube 1 while heating the tube 1, which is positioned horizontally, to a temperature of approximately 550 °C to 600 °C from outside so as to cause the dimethyl stannic chloride to decompose and oxidize, thereby to build up tin oxide. At the same time, antimony chloride is mixed into the vapor for antimony doping, thereby producing the transparent conductive coating 5. The transparent conductive coating 5 is formed on the whole inner surface of the tube 1 except at both ends of the tube 1 because it is less reactive at the ends of the tube.

In the next step, a coating solution is prepared by putting particulates of zinc oxide ZnO and titanium oxide TiO_2 of an average particle diameter of 0.1 μ m or less in a solvent such as butyl acetate and water. Then, the coating solution is poured into the tube 1, which is set upright, from the upper end of the tube in a known procedure so as to form a layer of the aggregation of the particles of zinc oxide ZnO and titanium oxide TiO_2 on the inner surface of the tube 1. Then, the coated film is naturally or forcibly dried to produce an unbaked metal oxide layer 6.

At this procedure, although the metal oxide layer 6 is formed also on the portions to be sealed at the ends of the tube 1, it is not peeled, and a phosphor coating solution, which is separately prepared, is coated on the unbaked metal oxide layer 6 to produce the fluorescent luminous layer 7.

In the next step, the both ends of the tube 1 are heated to preliminarily bake the both ends of the unbaked fluorescent luminous layer 7, and then, the fluorescent luminous layer 7 is peeled off from the portions to be sealed at both the ends of the tube 1 so that it does not interfere with the sealing. The phosphor can be easily peeled off, but the metal oxide layer 6 can be peeled slightly a little and it remains unremoved. This is attributable to the particle size of the particulate metal oxide which is only a fraction of dozens of the particle diameter of the phosphor particles. For example, the three-wavelength band luminous fluorescent lamp rare earth phosphor normally has an average particle diameter of 3 to 5μ m, and the antimony manganese co-activated calcium halophosphate phosphor of continuous wavelength luminescence has an average particle diameter of 5 to 10 μ m. The particulate metal oxide was found to be difficult to peel off because of the extremely small particles thereof and also because the metal oxide is partially baked when the both ends are preliminarily baked.

After peeling the coated phosphor film from the ends of the tube 1, the tube 1 is passed through a heating furnace which has been heated up to about 600 °C. This process is called a baking process. This baking process burns or removes binder ingredient, water content and other impurities which are contained in the coated metal oxide layer 6 and the fluorescent luminous layer 7, and hence, the metal oxide layer 6 and the fluorescent luminous layer 7, which were baked and are not peeled off, are formed.

Then, the glass stems 2, 2, which have discharge electrodes 3 with emitters attached thereto, are sealed onto both the ends of the tube 1 which has been subjected to the baking process. More specifically, the ends of the tube 1 and the stems 2 are heated with a burner, for example, until they are fused with each other to form the seal portion or section 4. At this time, the particles in the metal oxide layer 6 remaining on the inner surface of the tube 1 are completely or further melted and vitrified, thus being fused with the flare portion 2a together with the glass of the tube 1. This causes the metal oxide layer 6 to be held between the glass of the tube 1 and the glass of the flare 2a at the seal section 4, and a part thereof is melt and diffused into the glass material of the tube 1 and the glass material of the flare portion 2a.

After the above steps, the air is exhausted from the tube 1 through the exhaust tubes 2b of the stems 2 while heating the tube 1, and then, a rare gas and mercury are sealed in through the exhaust tubes 2b which are then cut and sealed. This process is called the sealing process. The bases 8 are mounted on the seal sections 4, 4 at both ends of the tube 1, thus completing the lamp L1.

It was found that, in the case of the fluorescent lamp L1 thus made, in the sealing process in which the tube 1 is heated until it softens, the metal oxide particles coated to the inner surface of the tube 1 is vitrified and fused, and therefore, the sealing can be accomplished without causing a crack, and no leakage occurs after sealing even if the metal oxide layer 6 remains inside the tube 1. This discovery overthrows the conventional belief that the metal oxide must be thoroughly removed.

In order to find the conditions which lead to good results, fluorescent lamps which employ different materials for the metal oxide layer 6 were made according to the same procedure described above. The results of the tests carried out by the inventor are shown in the following Table 1.

TABLE 1

Material	Mean Particle Diameter (μ m)	Film Thickness (μ m)	Percentage of Non-defective (%)
Al_2O_3	0.1	0.5	20
$0.5ZnO \cdot 0.5TiO_2$	Below 0.1	0.5	100
ZnO	0.1	0.5	100
SiO_2	0.5	1.0	0
$0.5ZnO \cdot 0.5TiO_2$	Below 0.1	0.5	100
$0.5ZnO \cdot 0.5TiO_2$	Below 0.1	1.0	90
Al_2O_3	Below 0.1	0.2	100
Al_2O_3	Below 0.1	0.5	25
Al_2O_3	Below 0.1	1.0	5

It is seen from the test results given above that the percentage of good products depends on the material and the percentage decreases if the thickness of the metal oxide layer 6 increases to about 1.0μ m or the particle diameter increases to about 0.1μ m. The observation of the metal oxide layer 6 at the seal section 4 of a defective product incurring a crack or leakage revealed that a considerable amount of particles of the metal oxide remained and little vitrification took place.

Thus, it can be understood that such a crack or leakage can be prevented by vitrifying the metal oxide layer 6 of the seal section 4. Taking this discovery and also the results given in Table 1 into account, it is seen that a greater particle diameter and a thicker metal oxide layer lead to less vitrification.

Further, it is anticipated that the material used also influences the vitrification. The results shown in Table 1 reveal that a mixture of ZnO and TiO_2, or ZnO alone promotes the vitrification in comparison with Al_2O_3. In fact, the inventor obtained an experiment result indicating that ZnO mixed with the soda-lime glass for fluorescent lamp lowers the melting point. This was not observed in the case of Al_2O_3. Further, ZnO and TiO_2 described in the above embodiment absorb ultraviolet rays of 400 nm or less, and therefore, they are

capable of restraining the deterioration in the transparent conductive coating 5 caused by the ultraviolet rays. As a result, the variation in the resistance can be minimized and the deterioration in the appearance due to blackening which is characteristic of the rapid start fluorescent lamp can be controlled.

A second embodiment of the present invention will be described hereunder with reference to Fig. 4. showing the sectional front view which partially shows an end of an annular fluorescent lamp L2. In Fig. 4, the same components to those of Fig. 1 to Fig. 3 are denoted by the same reference numerals and the explanation thereof is omitted.

The fluorescent lamp L2 in this embodiment has stems 2, which are provided with discharge electrodes 3, at both ends of the annular glass tube 1. The inner surface of the tube 1 is not provided with the transparent conductive coating 5, and instead, the metal oxide layer 6 and the fluorescent luminous layer 7 made of the same materials as those in the first embodiment are directly formed on the inner surface of the tube 1. The annular glass tube 1 is equipped with a base, not shown, which links both ends thereof. The fluorescent lamp L2 of this embodiment differs from the fluorescent lamp L1 of the first embodiment in that the tube 1 has a different shape, there is no transparent conductive coating 5, and the base has a different structure as stated above. In addition, the fluorescent lamp L2 has a different micro condition of the metal oxide layer 6 due to the difference in the manufacturing method as it will be discussed below.

Specifically, in the case of the fluorescent lamp L2, the tube is cleaned as in the first embodiment. Then, the step for forming the transparent conductive coating is omitted. The subsequent steps include a step for applying metal oxide, a step for applying phosphor, a step for preliminarily burning the ends of the tube , a step for removing the phosphor from the ends, a step for burning the metal oxide and the phosphor, a step for sealing in a stem, and a step for forming the tube into a ring shape. When sealing the stems, the seal section 4 is placed in a mold while the vicinity thereof is still soft so as to form an annular groove 4a around the sealing end for holding the tube 1 with a jig.

The whole tube 1, which has been sealed, is heated to nearly 700 °C to soften it and the annular groove 4a on one seal section 4 is held with a jig, and the tube 1 is wrapped around a round drum to shape into a ring. In this bending step, the tube 1 is heated at such a high temperature that the whole tube 1 softens, and the heat melts the metal oxide particles of the metal oxide layer 6 to vitrify it, so that it stretches or bent as the tube 1 is stretched or bent. At this time, pressure is applied inside the tube 1 to prevent it from being crushed.

After the above processes, the air is exhausted, mercury and a rare gas is sealed in, the exhaust tube is cut off and sealed, and the base is mounted to complete the fluorescent lamp L2.

The fluorescent lamp L2 in this embodiment also causes the metal oxide layer 6 at the seal sections 4 to vitrify. Hence, sealing can be accomplished without causing a crack or leakage regardless of the presence of the metal oxide layer 6 at the seal section 4.

Furthermore, in the case of the fluorescent lamp L2, the metal oxide layer 6 is vitrified all over the inner surface of the tube 1, thus allowing the metal oxide layer 6 to follow the stretching of the tube 1. This makes it possible to prevent the metal oxide layer 6 from developing a crack caused by particles retaining the particulate property which prevents the metal oxide layer 6 from stretching. The possibility of another problem, in which the particles in the metal oxide layer 6 retain the particulate property and bite in the tube 1 with a resultant reduced strength of the tube 1, can also be reduced.

Fig. 5 is a partial front view of a compact fluorescent lamp L3 illustrating a third embodiment of the present invention. In the drawing, the components which are identical to those of the first and second embodiments are denoted by the same reference numerals and the explanation thereof are omitted herein.

Referring to Fig. 5, the tube 1 of the fluorescent lamp L3 according to this embodiment has a junction 1d which connects projections 1b, 1b near one end of straight glass tubes 1a, 1a made of lead glass, and pinch- or press-sealed sections 4', 4' are formed on the other end. A pair of lead wires 3a supporting the discharge electrode 3 is sealed inside each of the pinch-seal sections 4', 4'. As in the first and second embodiments, the metal oxide layer 6 and the fluorescent luminous layer 7 made of the same materials as those of the embodiments described above are formed in double layers on the inner surface of the tube 1.

To manufacture the lamp L3, a coating liquid is applied inside the straight glass tube 1a to produce the metal oxide layer 6 and the coated liquid is dried, then the phosphor coating liquid is poured onto the metal oxide layer 6 to form the fluorescent luminous layer 7. Next, the fluorescent luminous layer 7 at each end of the tube is burned and the fluorescent luminous layer 7 is peeled from the portion at the end of the tube which is to be sealed as in the embodiments described previously.

In the next step, one end of the glass tube 1a is burned by a burner to close it. Then, two glass tubes 1a, 1a which have been closed, are prepared and the portions near the closed ends 1b, 1b which are located on the opposite side from the sections to be sealed, are heated by a burner to soften and melt them. Then, the melted portions are blown open by blowing a gas from the side of the sections to be

sealed, thus forming the projections 1c which are opened. The opened projections 1c, 1c of the two glass tubes 1a, 1a are set facing against each other and they are joined and fused with each other while they are still in a melted state, then, by blowing a gas in through the section to be sealed of one glass tube 1a, a hole which communicates with the junction 1d is formed, thus producing the tube 1 which approximately shapes like H.

In the subsequent step, with the lead wires 3a, 3a connected to the discharge electrode 3 made of a filament coil mounted at the section to be sealed of the tube 1 thus produced, the section to be sealed is heated with a burner to melt the end thereof and the melted end is pressed with a pinching device to form the pinch-sealed section 4.

The sealing process in this embodiment also causes the particles of the metal oxide layer 6 on the inner surface of the tube 1 adapted to melt and partially mix with glass to be fused with each other, making it possible to achieve sealing with satisfactory reliability. Hence, it is unnecessary to forcibly peel the metal oxide layer 6 from the section to be sealed.

Further, at the closed ends of the tubes and the junction, the particles of the metal oxide layer 6 are fused as the tube has been fused, so that the metal oxide layer 6 can follow the deformation of the tube. This prevents the metal oxide layer 6 from restraining the stretch of the tube and from consequently making it impossible to close and joint the ends.

Fig. 6 is a partial front view of a high-intensity discharge lamp L4 such as a metal halide lamp according to a fourth embodiment of the present invention. The high-intensity discharge lamp L4 has a double-tube structure wherein a light emitting tube 13 is housed in an outer tube 12 made of hard glass. The light emitting tube 13 is supported by a stem 14 sealed onto the outer tube 12. Reference numeral 15 denotes a seal section. The interior of the outer tube 12 is kept as an inert gas atmosphere or a vacuum atmosphere. The light emitting tube 13 has metal foil pieces 18, 18 sealed onto pinch- or press-seal sections 17, 17 at both ends of an inner tube 16 made of quartz glass, and discharge electrodes 19, 19 are connected to the metal foil pieces 18, 18. Mercury, metal halide and a rare gas are sealed in the inner the tube 16 as discharge media. A metal oxide layer 20 made of the same material as that in the first to third embodiments is formed on the inner surface of the outer tube 12.

The high-intensity discharge lamp L4 having the structure described above share the similar operation and manufacturing steps to those of a general high-intensity discharge lamp, and therefore, detailed explanation thereof is omitted herein. The manufacturing process of the high-intensity discharge lamp of the fourth embodiment differs only in the step related to the metal oxide layer 20.

In a case where it is required to manufacture the fluorescent lamp L4, the coating liquid of the metal oxide particles is coated to the inner surface of the outer tube 12 and dried so as to form the metal oxide layer 20 in the first step as in the first to third embodiments. Then, the stem 14 supporting the light emitting tube 13 is put in through the opening of the outer tube 12 wherein the metal oxide layer 20 coated up to the section to be sealed is kept unpeeled, and the section to be sealed of the outer tube 12 is heated and melted to seal with the stem 14.

As in the embodiments described previously, the glass of the outer tube 12 and the metal oxide particles in the metal oxide layer 20 on the inner surface are melted, and the metal oxide particles are partially mixed with the glass. Thus, the glass and the metal oxide particles are fused with each other, enabling the sealing to be accomplished with satisfactory reliability. Therefore, it is unnecessary to forcibly peel the metal oxide layer 6 from the section to be sealed.

The present invention is not restricted to the embodiments described above and it is applicable also, for example, to other type of fluorescent lamp, high-intensity discharge lamp, or incandescent lamp. Furthermore, the shape of the tube is not limited to those described in the embodiments, and three or more tubes may be interconnected and a communicating path such as a discharge path may be formed inside the connected tubes. Likewise, other materials ranging from soft glass such as lead glass to hard glass may be used for the tube rather than limiting the material of the tube to those discussed in the embodiments.

Furthermore, the metal oxide is not limited to the zinc oxide ZnO or the titanium oxide, and instead, one type of other oxide or a mixture of a plurality of types may be used for the metal oxide, such oxides including boron B, calcium Ca, lead Pb, arsenic As, antimony Sb, bismuth Bi, silver Ag, vanadium V, niobium Nb, titanium Ti, zirconium Zr, scandium Sc, yttrium Y, magnesium Mg, strontium Sr, rubidium Rb, cesium Cs, lanthanum La, and lanthanoid.

As described hereinbefore through the preferred embodiments, according to the present invention, the metal oxide is vitrified at least at the sealed sections, allowing the metal oxide to stretch, for example, as the glass member stretches. Hence, even if the metal oxide remains, there are fewer chances of the sealed sections incurring a crack or leakage after sealing. Therefore, the need for removing the metal oxide before sealing can be eliminated, or even when the metal oxide has to be removed, the removing procedure can

be simplified.

Claims

1. A lamp comprising:
a light-transmitting airtight container provided with a seal portion;
a light emitting means provided in said light-transmitting airtight container for emitting light; and
a metal oxide layer formed directly or indirectly on an inner surface of said light-transmitting airtight container and vitrified at least at the seal portion thereof.

2. A lamp comprising:
a glass tube;
a mount forming a light-transmitting airtight container together with said glass tube and having discharge electrodes sealed at the seal portions formed to the longitudinal end portions of the glass tube;
a metal oxide layer formed directly or indirectly on an inner surface of said glass tube and vitrified at least at the seal portions;
a fluorescent luminous layer formed on said metal oxide layer; and
a discharge medium sealed in said light-transmitting airtight container for exciting the fluorescent luminous layer.

3. A lamp comprising:
a light emitting tube containing a discharge medium sealed therein and having discharge electrodes so as to oppose to one another;
a light-transmitting airtight container containing said light emitting tube and having a seal portion; and
a metal oxide layer formed directly or indirectly on an inner surface of said light-transmitting airtight container and vitrified at least at the seal portion.

4. A lamp according to any one of claims 1 to 3, wherein a transparent conductive film is formed between the inner surface of said light-transmitting airtight container and said metal oxide layer.

5. A lamp according to any one of claims 1 to 3, wherein the seal portion is composed of a junction of two members and the metal oxide layer which has a vitrified metal oxide exists at the junction of the two members.

6. A lamp according to claim 5, wherein at least one of the two members of the seal portion is comprised of a glass member and the vitrified metal oxide layer is formed at least on a side of said glass member of the seal portion.

7. A lamp according to one of claims 5 and 6, wherein at least one of the two members of the seal portion is comprised of a glass member and the metal oxide layer comprises a metal oxide diffused in the glass member at the seal portion.

8. A lamp according to claim 1, wherein the seal portion comprises an end of the light-transmitting airtight container which is pinch- or press-sealed.

9. A lamp according to any one of claims 1 to 8, wherein the metal oxide is comprised of fused particles in the seal portion.

10. A lamp according to any one of claims 1 to 9, wherein the metal oxide layer comprises metal oxide particles except at the seal portion and in the vicinity thereof.

11. A lamp according to claim 10, wherein average primary particle size of the metal oxide particles is of 0.1 μ m or less and average thickness of the metal oxide layer is 0.5μ m or less.

12. A lamp according any one of claims 1 to 11, wherein the metal oxide layer includes zinc oxide as one of constituents thereof.

13. A lamp according to claim 2, wherein the fluorescent luminous layer is formed on the metal oxide layer corresponding to an area of the metal oxide layer without excluding at the seal portions.

14. A lamp according to claim 2, wherein the fluorescent luminuos layer is formed inside the metal oxide layer substantially entirely corresponding to the surface of the metal oxide layer

15. A lighting apparatus comprising:
a main body;
a lamp mounted to the main body and having a structure defined in any one of claims 1 to 3; and
an operating unit mounted to the main body for operating the lamp.

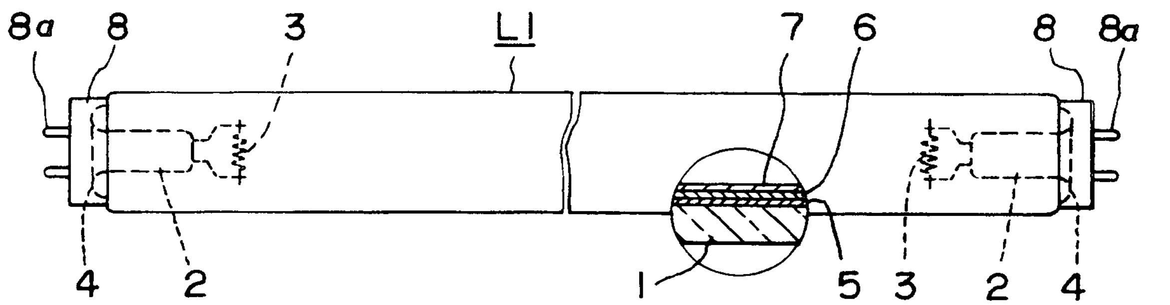

FIG. 1

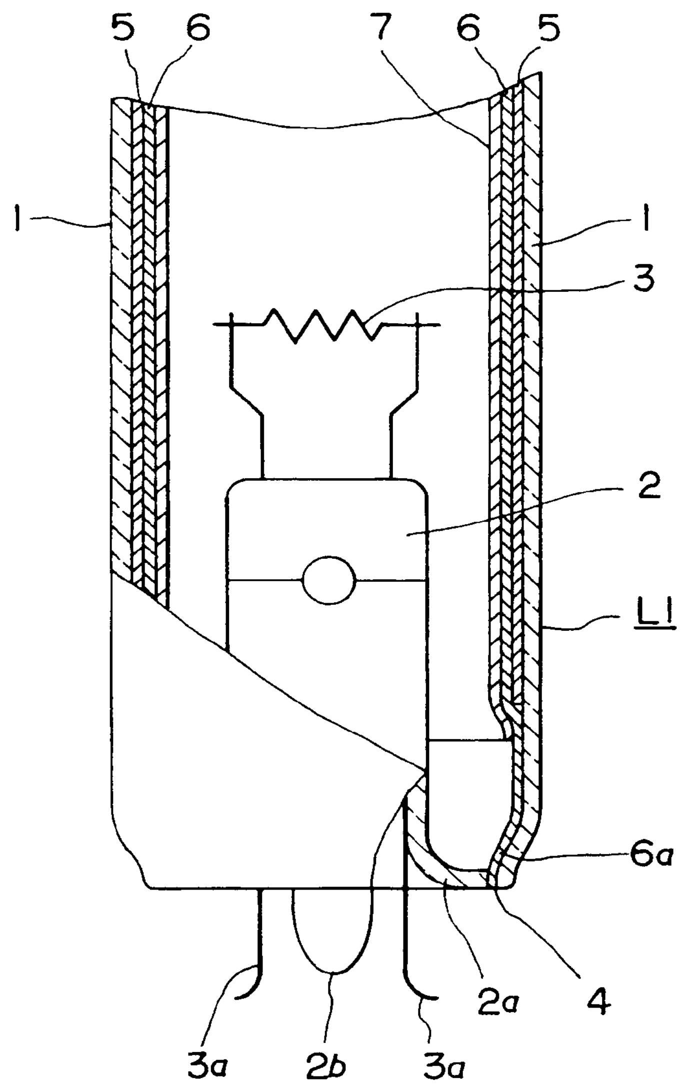

FIG. 2

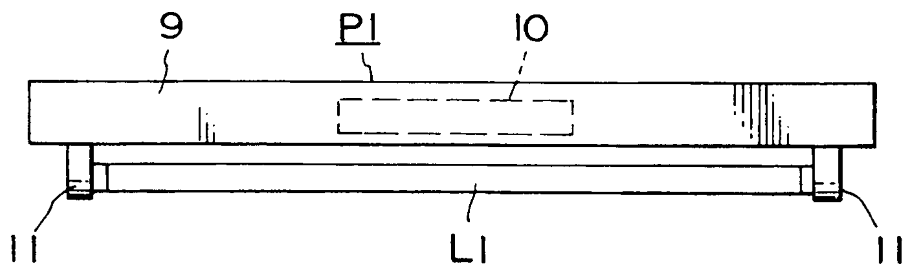

FIG. 3

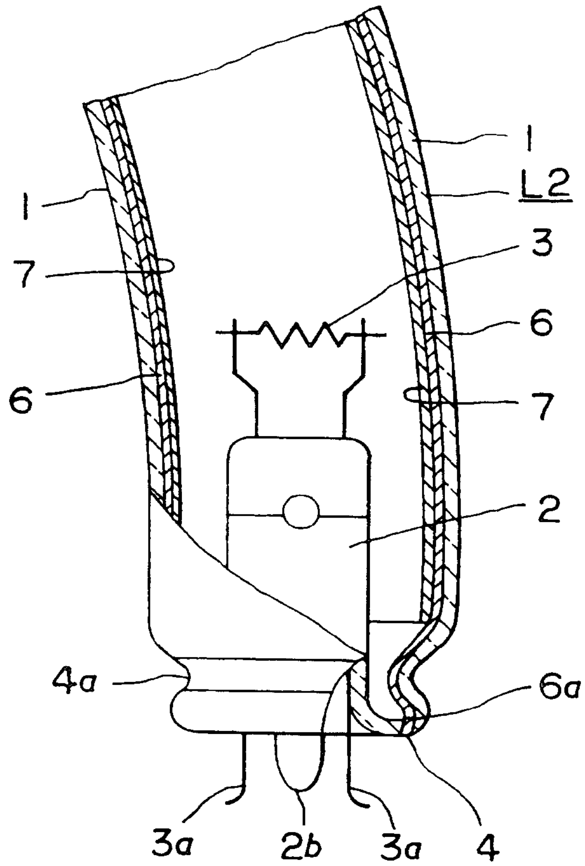

FIG. 4

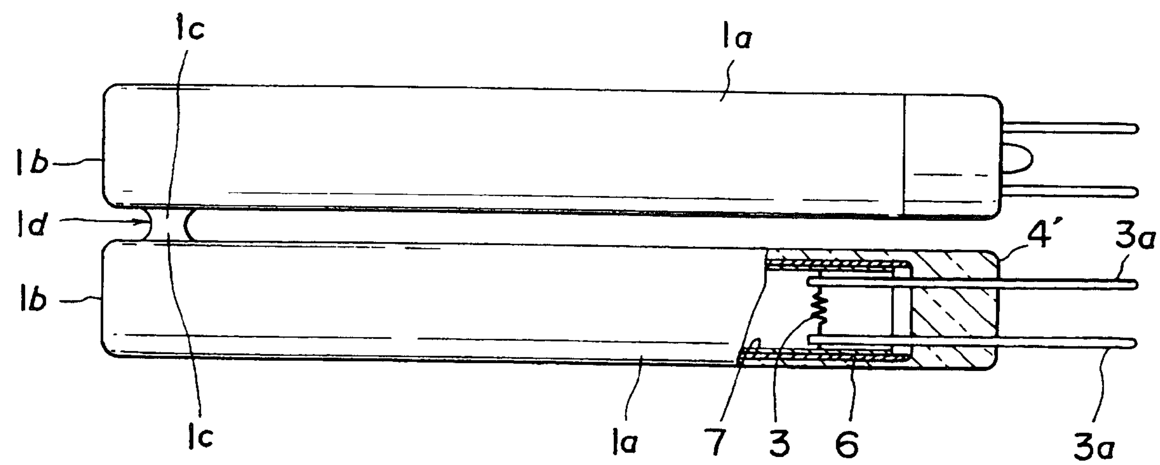

FIG. 5

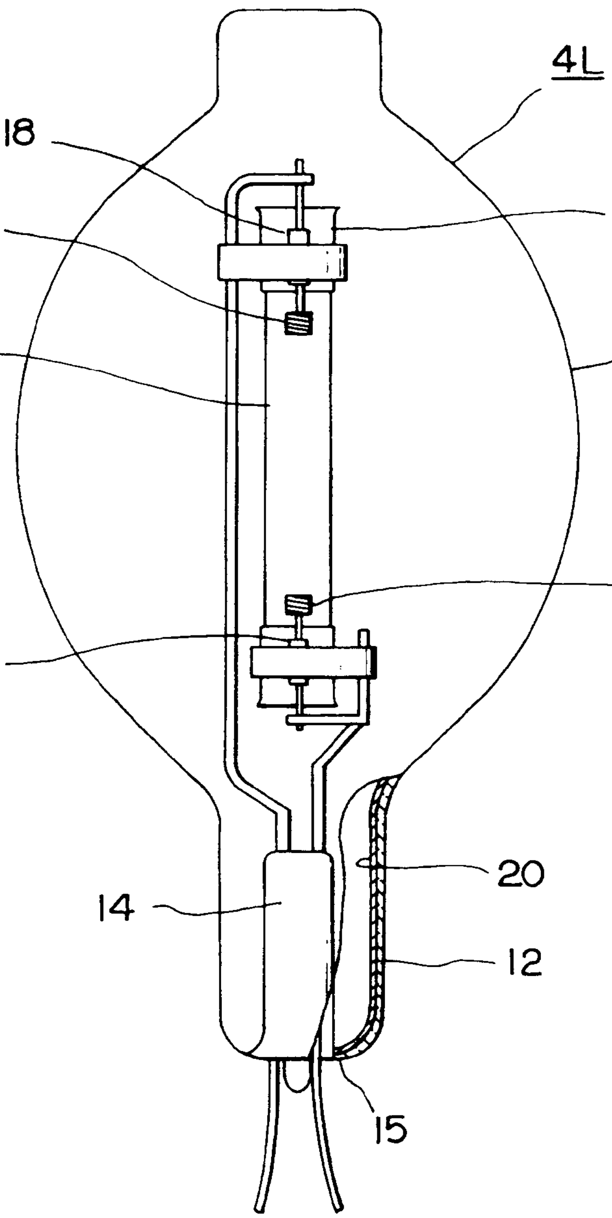

FIG. 6

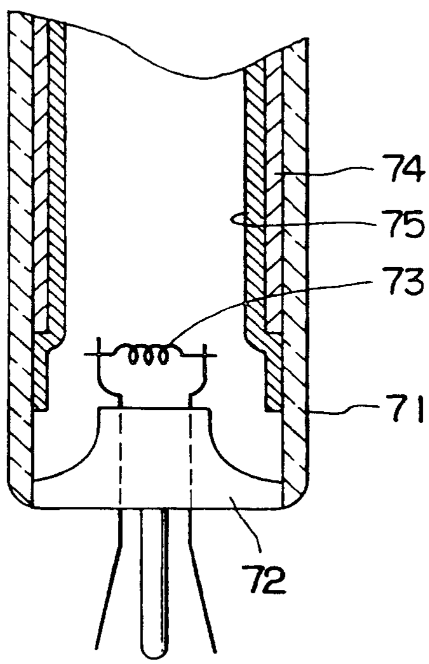

FIG. 7
PRIOR ART

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 12 0798

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	AU-B-420 209 (TOKYO SHIBAURA ELECTRIC COMPANY LIMITED AND TOKYO TORAY INDUSTRIES INC) * page 1, line 13 - line 15 * * page 2, line 33 - page 3, line 4 * * page 5, line 6 - line 8 * * page 5, line 17 - line 22 * * page 5, line 33 - page 6, line 3; claims 1-3; figure 1 * ---	1,3,8,9,15 2,4	H01J61/35 H01J61/36 H01J9/26
X Y	FR-A-793 803 (COMPAGNIE DES LAMPES) * page 1, line 27 - page 2, line 3 * * page 3, line 44 * ---	1,3,9,15 2,4	
Y	GB-A-2 066 562 (TOKYO SHIBAURA DENKI KABUSHIKI KAISHA) * abstract; figure 5 * * page 1, line 45 - line 56 * * page 1, line 107 * ---	2,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	EP-A-0 389 717 (SUMITOMO CEMENT CO. LTD.) * abstract * * page 2, line 53 * * page 4, line 25 - line 31 * ---	11,12	H01J H01K
A	GB-A-2 044 524 (PATENT-TREUHAND-GESELLSCHAFT FUR ELEKTRISCHE GLUHLAMPEN MBH) * abstract * -----	11	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 April 1995	Martín Vicente, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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